CMWR 2008 STUDENT FELLOW AWARDEE

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TITLE: Experimental Determination of Dynamic Coefficient in Porous Media

ABSTRACT):

The multi-phase flow behaviour in porous media is described by the relationships among capillary pressure (Pc), saturation (Sw) and relative permeability (Kr). It has been shown that conventional quasi-static equations may not be applicable in dynamic conditions when Pc strongly depends on saturation and saturation changes with time ($\partial Sw/\partial t$). The dependence of Pc on $\partial Sw/\partial t$ is known as dynamic effect. To address this issue, dynamic capillary pressure-saturation (Pc-S) relationships have been proposed which include an additional term to account for dynamic effect. The additional term has a coefficient called 'capillary damping' or 'dynamic coefficient' (τ), which establishes the speed at which flow equilibrium is reached. Despite many studies indicating the importance of dynamic effect, there are few experimental studies aimed in quantifying this, particularly in three dimensional (3D) domains. Consequently, there are significant uncertainties on the values of τ in the literature. This issue is investigated by an experimental study to establish vertical two-phase flow for drainage and imbibition of 3D homogeneous media.

In this work, locally measured Pc-S curves are determined at dynamic and quasi-static flow conditions at three different heights of homogenous domains. The local Pc-S and $\partial Sw/\partial t$ - t data are then used to determine experimental dynamic coefficient, τ. As expected, the results confirm that at the same saturation, the corresponding capillary pressure is higher for dynamic than for quasi-static conditions. Also, for similar transient flow conditions, the Pc-S curve for a low permeability medium lies higher than for a medium with higher permeability. The dynamic coefficient (τ), as a measure of dynamic effect, is a non-linear function of saturation and depends on porous media permeability and history of saturation (drainage or imbibition). In drainage condition, locally determined dynamic coefficient as a function of water saturation (τ-S) slightly varies from one location to the other but the functional dependence follows similar trends at different heights. Therefore, saturation weighted average of local τ-S curves is defined as an effective τ-S curve for the whole domain and follows an exponential trend. In imbibition case, however, τ-S curve does not flow a clear trend but lies higher than drainage curve.